SAN GORGONIO HYDROELECTRIC SYSTEM, POWERHOUSE NO. 2
San Bernardino National Forest
Banning vicinity
Riverside County
California

HAER CA-2278-G
HAER CA-2278-G

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

FIELD RECORDS

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
1849 C Street NW
Washington, DC 20240-0001

HISTORIC AMERICAN ENGINEERING RECORD

SAN GORGONIO HYDROELECTRIC SYSTEM,
POWERHOUSE NO.2

HAER No.CA-2278-G

Location: Powerhouse No. 2 is located roughly 5.3 miles southwest of the East and South Fork Dams and Intakes and 1.1 miles southwest of Tank No. 2. Powerhouse No. 2 is located in the Riverside County portion of the system within Banning Canyon. It is located in Sections 8; T.2S., R.1E. on the Forest Falls USGS topographic map. Powerhouse No. 2 is located at latitude: 34.018537, longitude: -116.894919. The coordinate represents the center of the Powerhouse No. 2 building. This coordinate was obtained on June 30, 2010 using a GPS mapping grade unit accurate to +/- 3 meters after differential correction. The coordinate's datum is North American Datum 1983. The Powerhouse No. 2 location has no restriction on its release to the public.

Date of Construction: 1923

Builder: San Gorgonio Power Company

Present Owner: Southern California Edison Company
(fee ownership and easements)
2244 Walnut Grove Avenue
Rosemead, CA 91770

Present Use: Vacant

Significance: Powerhouse No. 2 is a contributing feature to the San Gorgonio Hydroelectric System. The system itself is was found to be eligible for listing in the National Register of Historic Places under Criteria A and C in 1993. The system was found eligible under Criterion A, for its representation of 1920s hydroelectric development in southern California and the system was also found to be eligible under Criterion C, for its use of tanks rather than forebays, which represented a departure from typical western hydroelectric systems, using a technique more common to the eastern United States. Furthermore, the San Gorgonio System utilized automatic controls which were a new innovation in the 1920s and later became an industry standard. Additionally, the two powerhouses were found to be good examples of utilitarian structures influenced by Classical Revival style architecture.

Report Prepared by: Ben Taniguchi, Historian II and Nicole Collum, Architectural Historian II
Nicole Collum, Architectural Historian II
Galvin Preservation Associates
1611 S. Pacific Coast Highway, #104
Redondo Beach, CA 90277

Date: September 2010

Project Information: SCE is planning to decommission the project's two power plants and part of their appurtenant water conveyance system. Some of the project components are scheduled to be decommissioned and removed, decommissioned and abandoned in place, or transferred to new ownership. The hydroelectric generators and other pieces of hardware and equipment will be removed from the powerhouse buildings, but the buildings will remain. Components slated for removal will be demolished using

bulldozers and other components will be removed using hand crews where there is no present vehicle access. The San Gorgonio Pass Water Agency plans to acquire those project facilities that are not decommissioned. The transferred facilities would no longer be used for the generation of power. As a result of this project the San Gorgonio Hydroelectric System was documented with Historic American Engineering Records. The entire system was documented in an overview report, San Gorgonio Hydroelectric System HAER No. CA-2278 and each contributing element of the system was documented with separate supporting reports as follows: San Gorgonio Hydroelectric System, East Fork Dam and Intake, HAER No. CA-2278-A; San Gorgonio Hydroelectric System, South Fork Dam and Intake, HAER No. CA-2278-B; San Gorgonio Hydroelectric System, Powerhouse No. 1, HAER No. CA-2278-C; San Gorgonio Hydroelectric System, Tank No. 1 and Penstock No. 1, HAER No. CA-2278-D; San Gorgonio Hydroelectric System, Operator's Bungalow, HAER No. CA-2278-E; San Gorgonio Hydroelectric System, Operator's Garage, HAER No. CA-2278-F; San Gorgonio Hydroelectric System, Powerhouse No. 2, HAER No. CA-2278-G; San Gorgonio Hydroelectric System, Flowline No. 2, Tank No. 2, & Penstock No. 2, HAER No. CA-2278-H.

Part I. Historical Information

Physical History

The San Gorgonio Hydroelectric System was constructed from 1911-1923. Construction on Powerhouse No. 2 began in 1922 and was completed in 1923. The original proposed drawing of Powerhouse No. 2 was drawn by S.L.B. (likely an in-house architect or draftsman) and is dated August 16, 1923. The original general specifications for the water wheel, governors and hydraulic equipment contained within Powerhouse No. 1 and 2 is dated July 14, 1922 and signed by Chief Engineer Charles O. Poole. An original 11-page type written document showing general specification for the generators, transformers, switchboards and control equipment contained within Powerhouse No. 1 and 2 is dated July 13, 1922 and is unsigned; the document was supplied to potential equipment suppliers prior to the construction of Powerhouse No. 2. The contractor for the building was C.D. Sotiras.

Physical alterations that have been made to the building include: re-sheathing the roof with corrugated metal, cladding the exterior concrete in stucco and the replacement of the pedestrian entrance doors on the northwest and southeast elevations and the addition of security grills. Although, the precise dates of the above alterations are not known the corrugated metal roof, stucco sheathing of the concrete and the addition of security grills appears to date from the 1960s when Southern California Edison acquired the property. The original paling fence around the transformers and the building likely occurred prior to SCE acquiring the property as a safety precaution; however the exact date of these alterations is not known.

Historic Context

Although, the Los Angeles based, Consolidated Reservoir and Power Company (CRPC), had initially planned to construct a hydroelectric power plant along the Whitewater River in 1906, concrete construction plans for a hydroelectric plant were not established until 1921 when CRPC reorganized as the San Gorgonio Power Company (SGPC). The company's objective was to utilize the already existing concrete irrigation conduit as a flowline for a series of power plants along the Whitewater River. Once the project was completed the company would then sell the power produced to the Southern Sierras Power Company, who at the time provided electricity to the city of Banning. SGPC hired Charles O. Pool as the chief project engineer and C.D. Sotiras as the contractor.[42] SGPC chose to construct both powerhouses for the system in the Classical Revival Style, which had been influencing the construction of powerhouse design since 1910.[43] By September of 1922, construction began on both Powerhouse No. 1 and Powerhouse No. 2 which were designed to work in tandem, as a comprehensive system.[44]

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[42] Weber, Carmen A. and Richard Starzak. *A Historical Assessment of the San Gorgonio Hydroelectric System*. Irvine, CA: Chambers Group, Inc., 1993, p. 3.
[43] S. D. Mikesell. National Register of Historic Places Nomination, Kern River No. 3 Relicensing Project. Prepared by ENTRIX, Inc. for Southern California Edison Company, 1989 p 4.
[44] "Power Plants Going In," *The Banning Record*, September 28, 1922, p. 1.

Powerhouse No. 2, also known as "Pine", was constructed in Banning Canyon, situated at approximately 1,100' downstream from Powerhouse No. 1. The mechanical equipment for Powerhouse No. 2 was purchased from the Westinghouse Electric and Manufacturing Company in Pittsburg Pennsylvania and shipped to the project site. The mechanical equipment inside the powerhouse consisted of a water wheel, generator, exciter, switchboard, and control equipment. The water wheel was a 1,030-horsepower Pelton impulse water wheel, controlled by a Pelton type 0.3 stream deflecting governor. The generator, was a Westinghouse 938-kilowatt (kW), 2,400-volt, 60-cycle, three-phase, 514-RPM generator, which was mounted on the shaft next to the wheel. The shaft terminated at a Westinghouse 15-kW, 125-volt exciter. A switchboard with mounted operating controls monitored the system and a Venturi meter read the water flow through the plant. The transformer equipment located outside the powerhouse consisted of three Westinghouse single-phase 300 kV-a, Oil Insulated Self Cooled , 60-cycle, 2,400/34,500-volt transformers with two full-capacity taps on high-and low tension windings.[45]

Powerhouse No. 2 was placed into service on December 12, 1923, 12 days after Powerhouse No. 1 had been placed into service.[46] By August of 1923 the system had a generating capacity of 3,300 volts and fed into the Southern Sierras trunk line.[47] However, the output of the powerhouses was not sufficient enough to meet the power demands of the residents of Banning, especially during peak usage. Thus they were later downgraded to back-up status. Due to their back-up status, Banning continued to receive its primary power from the SSPC.[48] In 1932, SGPC reorganized as the San Gorgonio Electric Company, following financial difficulties as a result of the 1930s economic depression.

In 1938, massive flooding affected areas of both Riverside and San Bernardino counties, when the Santa Ana River, which is linked with the Whitewater River, jumped its banks.[49] The flooding washed out sections of the flowlines near both the east and south fork intakes, significantly damaging the water intake system for Powerhouse No.1. The damaged sections were immediately repaired with spiral weld steel pipes that were reinforced to withstand any future flooding or landslides. This flood also destroyed an operator's cottage located at was originally located at the Powerhouse No. 2 site. On January 9, 1950 the San Gorgonio Electric Company sold the plant to the California Electric Power Company and on December 31, 1963 the San Gorgonio Hydroelectric system became part of the Southern California Edison Company by license transfer (this occurred when California Electric Power merged with the Southern California Edison Company). SCE continued to use both the former SGPC power generating facilities until they were finally shutdown in 1998 after Tank No. 1 collapsed; the property remains

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[45] SCE Manuscript, Operating Instructions and Description of the San Gorgonio Power Company System, Prepared by A.F.A., Engineering Department, August 1928. p. 2.
[46] B.J. Mount and H. L. Fryer. "Southern/Hoover Hydro Generation Division History," Southern California Edison Manuscript, May 21, 1980.
[47] *Southern Sierras Service Bulletin*, Vol. 2, Number 11 August 1923.
[48] Weber, p. 222.
[49] "Plane Trip Shows Scene of Desolation," *Los Angeles Times*, March 4, 1938, p. 1.

under ownership of SCE.[50] The irrigation system remains in operation (as of 2009) and the water rights are still owned by the Banning Heights Water Company; the system is owned and maintained by SCE.

Please see the Historic Context section in the Historic American Engineering Record for the San Gorgonio Hydroelectric System (HAER No. CA-2278) for additional information.

Part II: Description: Structural/Design Information

General Description

The San Gorgonio Powerhouse No. 2 (also known as Pine Powerhouse) is utilitarian in style but has elements of the Classical Revival style. The one-story building has a rectangular floor plan that at the exterior measures 25' x 34'-9-5/8". It has a reinforced concrete structural system with a two-by-three-bay plan (two bays on the ends and three on the side elevations). The exterior is clad with textured stucco cladding. A gabled roof sheathed with corrugated metal covers the powerhouse. One of the few decorative elements on the building consists of gable ends with shallow eaves with a cornice that frames a triangular louvered vent. Fenestration consists of large metal sash industrial awning windows with 30 panes each; the windows are located on all sides of the building and are covered by metal mesh security screens. The width of the window openings measures 8'-3-5/8". Pedestrian entrances are located on the northwest and southeast elevations of the powerhouse and consist of non-original single flush wood door. A large service entrance is situated on the southwest elevation that consists of an eight foot wide sliding wood door with diagonal grooved wood slat construction; the wood doors are covered with mesh screen security doors. The perimeter of the building is paved with a concrete walkway. The powerhouse, including a switch rack is surrounded by an eight-foot tall chain link fence that is topped by barbed wire.

Condition

The overall condition of Powerhouse No. 2 is good. It appears to be structurally sound and there appears to be no deterioration of the exterior or interior.

Exterior

A steel bi-level switch rack that makes up the switchyard is located near the northern end of the powerhouse. The switch rack rests on a concrete pad that measures approximately 18' x 26'. There is also an eight-foot tall chain link fence between the rack and the powerhouse.

The electrical equipment used in the switch yard consists of the following:

- A total of three circa 1920s ***Westinghouse*** **single phase transformers**.

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[50]Timothy Smith, "Water Restoration Plan Passes 1st Vote," *Record Gazette* , November 29, 2007 website accessed November 2009 http://www.recordgazette.net/articles/2007/11/30/news/01news.prt.

- There are also a several row of **ceramic insulators** on the upper and middle levels of the switch rack.

Interior

The entire floor of the powerhouse is clad with concrete that is scored in a geometric pattern. Powerhouse No. 2 contains equipment used for power generation. There are steel rafters that braces the roof and the trusses rests on an upper concrete ledge; the rafter system runs the length of the building and a single steel I-beam is attached to the trusses and is used as a track for an equipment crane. The power generating equipment is located on the southeast side of the powerhouse and a control panel and a resistor is located on the northwest side; there is also a wood booth at the southeast corner of the room that contains a toilet and a sink attached to the outside of the restroom booth. The interior is illuminated with light fixtures consist of circa 1950s rafter mounted industrial double tube fluorescent lights with hoods. There is also a circa 1950s rafter mounted emergency light with a porcelain shade.

The power generating equipment consists of the following:

- ***Pelton*** **impulse 2,330 horsepower water wheel** (from the early 1920) that is powered by water fed through penstock and the flow controlled by a **TSO valve**; the flow of the water is measured by the original **Venturi meter**, which is attached to the base of the water wheel. The water wheel itself is covered by a rounded riveted steel cover with metal block letters that spells out P-E-L-T-O-N.
- ***Westinghouse*** **alternating current generator** (from the early 1920) 1,875 kilowatt, 2,400 volt, 60 cycle, three phase, 720 rotations per minute) that is powered by the water wheel via a shaft. The generator is mounted on a cast iron base and is installed over a tub that is used to make room for the lower half of the generator. The center of the turbine is covered by a steel cover vent openings and the ends are covered by a metal cage.
- **Control panel** (from circa 1920s) containing switches and gauges used to control and monitor the generator and water wheel; most of the switches and gauges have been replaced; only four circa 1920s gauges remain.
- ***Westinghouse*** **resistor** (from the early 1920) that controls the amount of direct current power that was transmitted to the generator field (inside of the generator).
- ***Kelman Electric*** **oil filled generator circuit breaker** (from circa early 1920)
- ***Yale Spur Geared Block*** **crane** (from circa early 1920) that is controlled by a metal chain and pulley with an attached metal hook. The crane was used to carry sections of the power generator, which have metal loop hooks.

Mechanical Operation

The operating mode for Powerhouses No.1 and No. 2 of the San Gorgonio Hydroelectric System are unique in conception. Since the system gathers its water source from multiple streams, water could not be stored in a standard forebay, instead the system utilized tanks and relied on a special automatic system to maximize the flow of water.

The operator for Powerhouse No. 1 would regulate the operation of Powerhouse No. 2 by remote control. This remote control system included: a push-button control for starting and stopping Powerhouse No. 2; a push button control of the load carried at Powerhouse No. 2, depending on the water level available in Tank No. 2 and an automatic control to shut down Powerhouse No. 2 when the available water level dropped below the minimum allowable. The system also used the following remote indicating devices with the electrical equipment: a water level indicator at both Powerhouse No. 1 and No. 2 for Tank No. 2, a load indicator at Powerhouse No. 1 for the load carried at Powerhouse No. 2 and audible indicator at Powerhouse No. 1 for when Powerhouse No. 2 goes off line automatically.[51]

They system was operated 16 hours a day, with powerhouse operators working in two 8-hour shifts. To begin the 16-hour cycle, the operator at Powerhouse No. 1 would manually start Powerhouse No. 1. Shortly after , the operator at Powerhouse No. 1 would start Powerhouse No. 2 from remote control. This system worked based on the assumption that Tank No. 2 would be full because at the end of the previous day the water from the Powerhouse No. 1 flowline would have been collected at Tank No. 2, filling the tank, when the system was shut down. Powerhouse No. 2 would carry a full load until Tank No. 2 reached the half empty mark. Once this mark was hit, the load would be automatically reduced to a compatible level of Powerhouse No. 1 since, by that time, water from Powerhouse No. 1 would have reached Tank No. 2. Just before the end of the 16-hour cycle, Powerhouse No. 2 was increased to a full load so that the water in Tank No. 2 would fall to the lowest operating level. Once this occurred, Powerhouse No. 2 would be automatically shut down. The operator at Powerhouse No. 1 would shut down Powerhouse No. 2 once he received notification that Powerhouse No. 2 had been shut down. The water would then flow from Powerhouse No. 1 to Tank No.2, to fill the tank for operating the 16-cycle for the following day. [52]

When the water levels were low, the system could only be operated when Tank No. 1 was sufficiently full. When this occurred the system could be operated at 50 percent or more capacity. One of the primary advantages to the design of the San Gorgonio Hydroelectric System was that it only required two operators to be on-site. A single operator at Powerhouse No. 1 to oversee the operation of Powerhouse No. 1 and Powerhouse No. 2 and a single operator at Powerhouse No. 2 which could leave the powerhouse to conduct routine maintenance throughout the system, including overseeing the flowlines and other mechanical equipment. [53]

The system became fully automated by 1980. Once the system became fully automated each powerhouse was connected by a cable to its respective tank. Once the tank was full, a control signal was initiated to start the plant. This signal initiated the opening of the turbine needles to provide adequate water to operate the turbines at high efficiency.

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[51] P.B. Garrett, Automatic Hydro-Electric Plant of the San Gorgonio Power Company. The Electric Journal, Vol. XXII, No. 6. p.286.
[52] Ibid p.286-287.
[53] Ibid p.286-287.

When the water level in the tanks was at a predetermined low water level, the turbines were signaled to shut down and the cycle repeats. The units were synchronized to the system as synchronous motors, aided by speed switches and the generators' amortizer windings.[54] The system was finally shutdown in 1998 following the collapse of Tank No. 1.

Site Information

Powerhouse No. 2 is located roughly 5.3 miles southwest of the East and South Fork Dams and Intakes located Whitewater River and 1.1 miles southwest of Tank No. 2. It is 4,200 feet above sea level. Powerhouse No. 2 is one of two powerhouses in the San Gorgonio Hydroelectric System that contained equipment used to generate electrical power. The source of water for SG 2, Whitewater River originates at San Gorgonio Mountain.

Part III: Sources of Information

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[54] Ibid p. 50.

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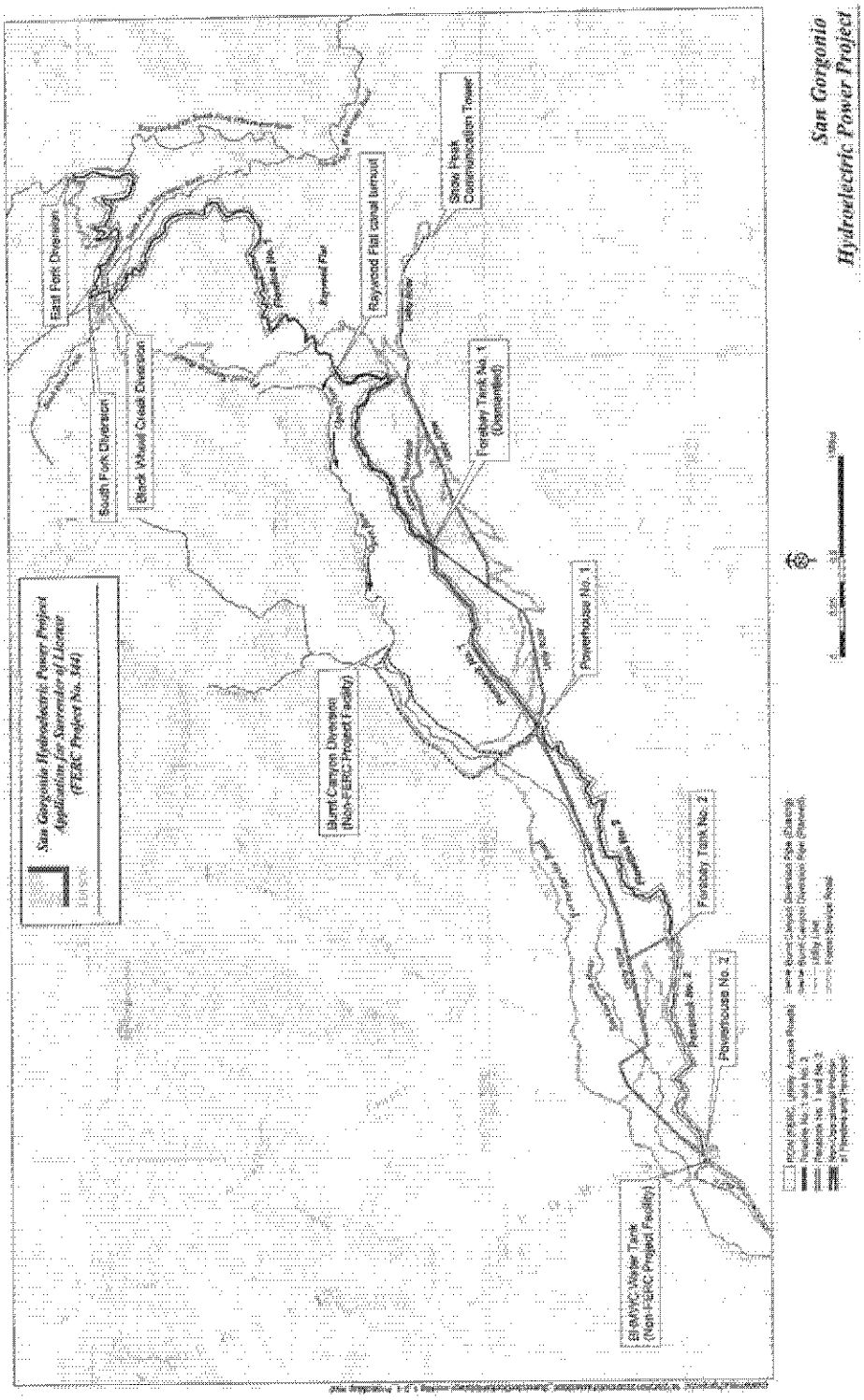
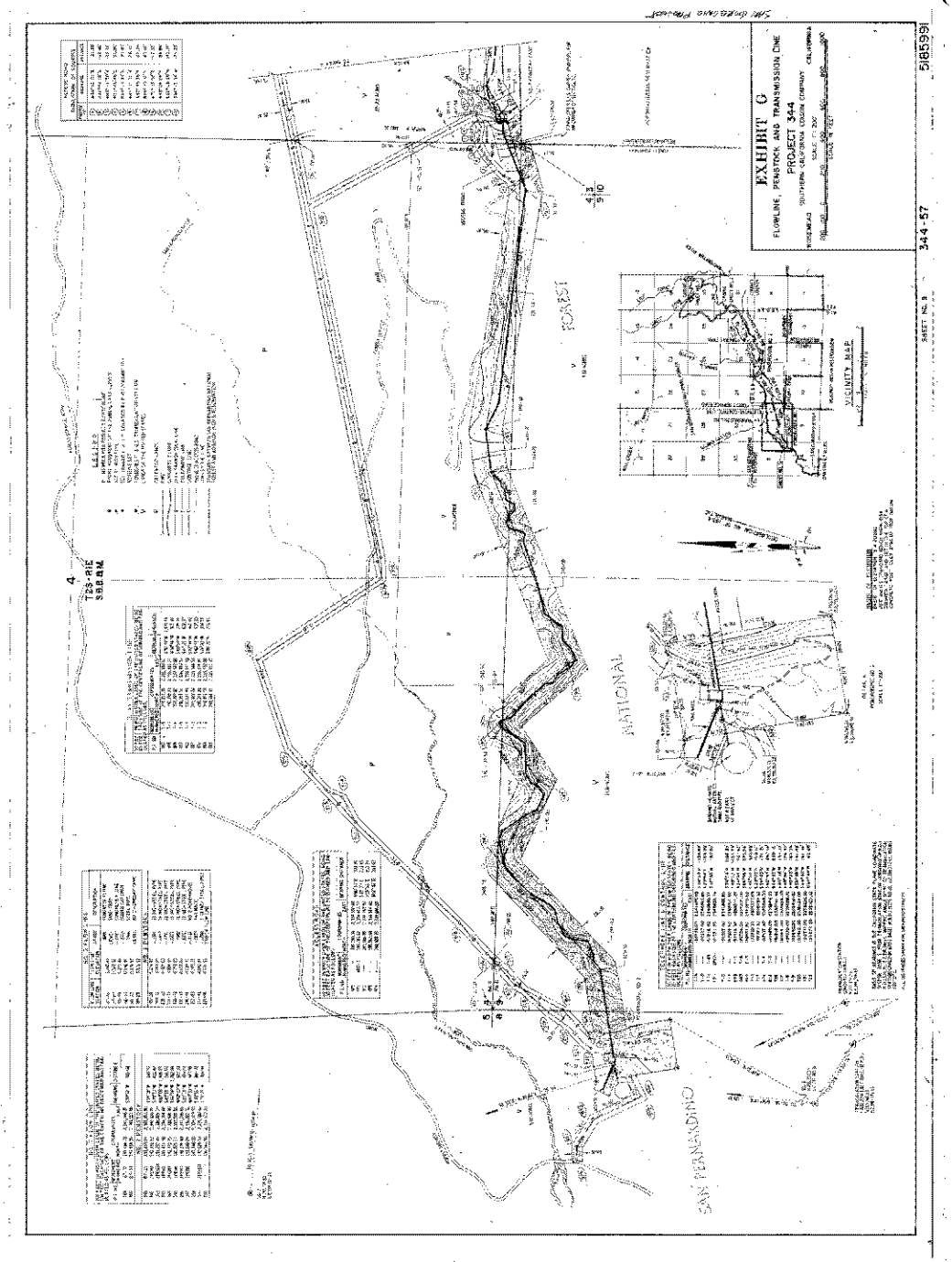
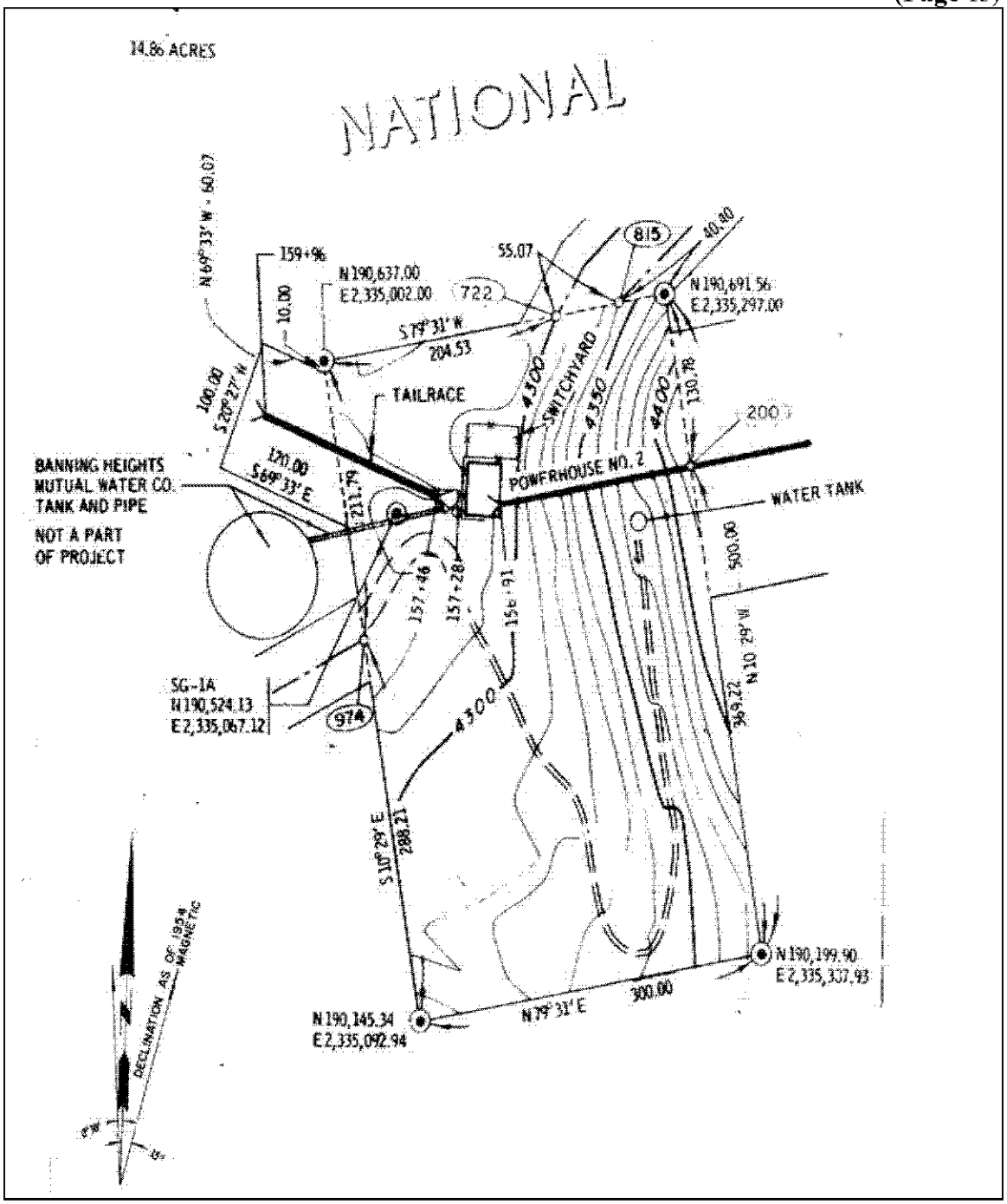


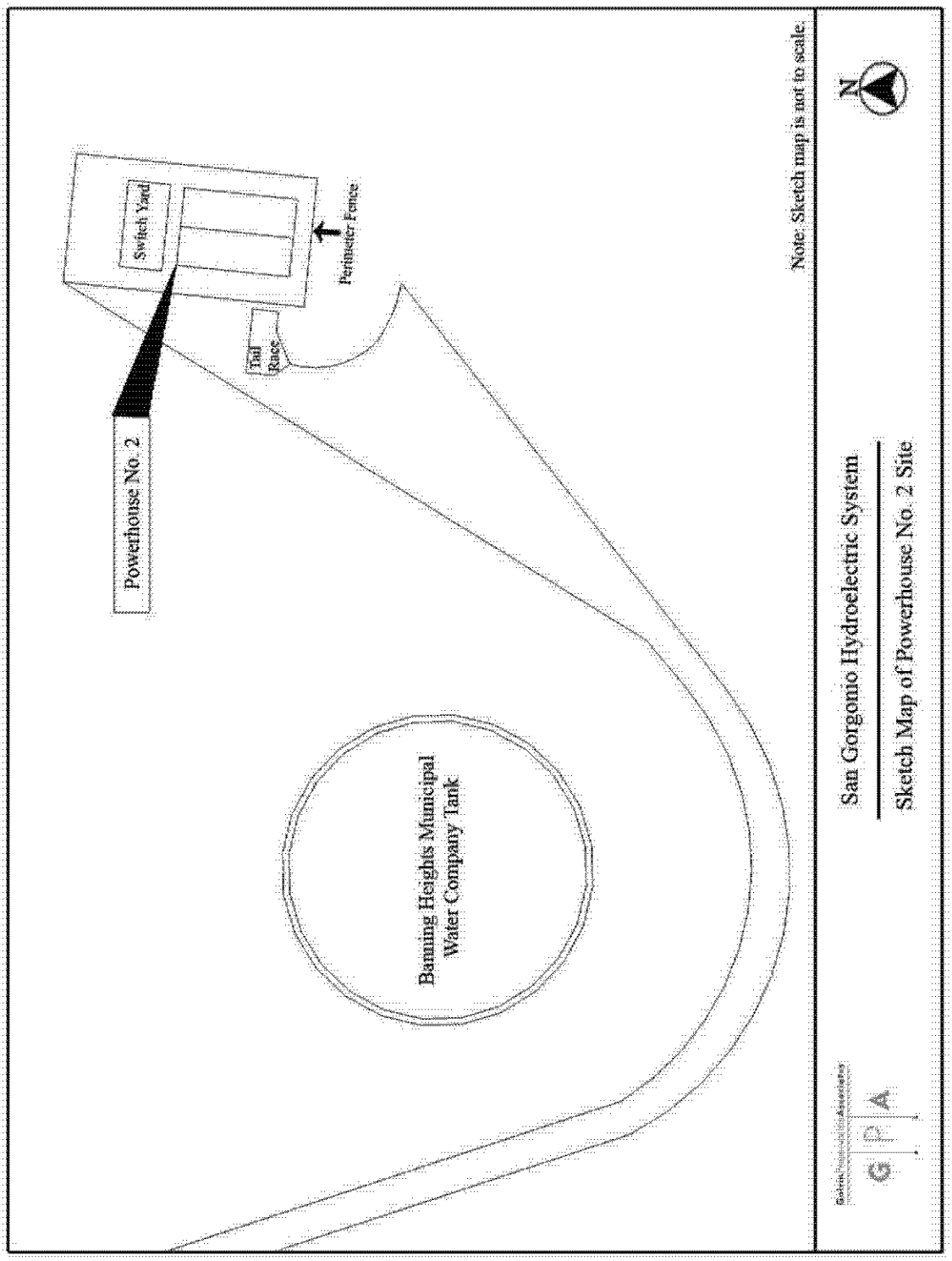
Reduced size overview map of the San Gorgonio Hydroelectric System. Map courtesy of Southern California Edison Company



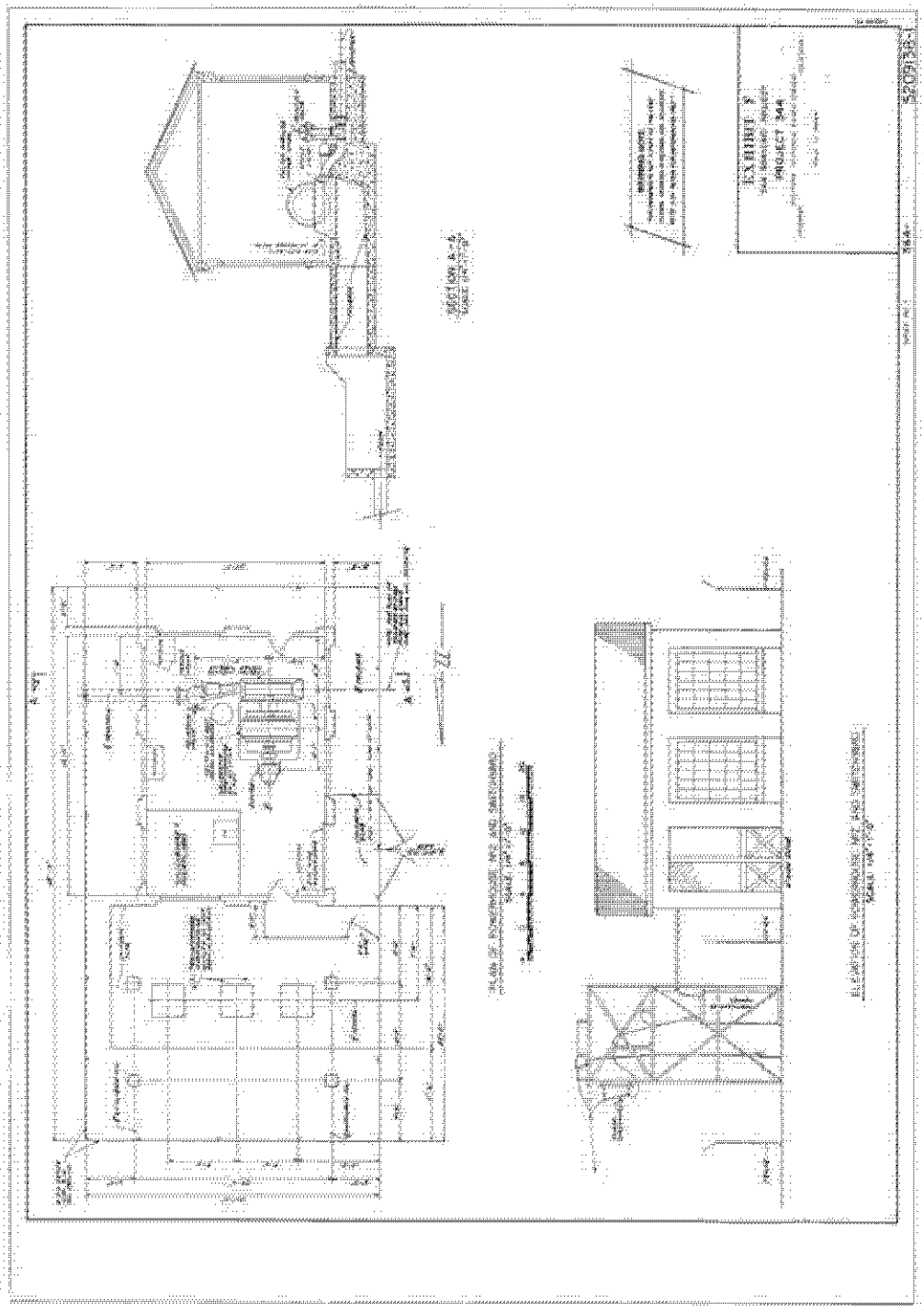
Reduced size plan of Flowline No.2, Penstock No.2, Transmission Line and Powerhouse No.2 site. Original drawing courtesy of Southern California Edison. Full size image available in the Field Records Section of the HAER for the San Gorgonio Hydroelectric System, HAER No. CA-2278.



Detail view of Powerhouse No. 2 taken from previous reduced size plan drawing. Original drawing courtesy of Southern California Edison.



Sketch map of Powerhouse No. 2 . Sketch map created by Galvin Preservation Associates, 2010.



Reduced size engineering drawings of Powerhouse No. 2. Original drawing courtesy of Southern California Edison. Full size image available in the Field Records Section of the HAER for the San Gorgonio Hydroelectric System, HAER No. CA-2278.